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Hippotherapy as a Tool for Improving Motor Skills, Postural Stability, and Self Confidence in Cerebral Palsy and Multiple Sclerosis

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I. INTRODUCTION

Neuromuscular disorders are important to investigate to identify causes that lead to disability and to provide appropriate treatments for those affected. Developing innovative treatments can lead to functional improvement in a variety of skill levels (Sanger, 2003). Two important neuromuscular disorders to consider are cerebral palsy (CP) and multiple sclerosis (MS). Incidence research suggests that CP affects every two children in 1,000 births and is the most likely cause of movement disorders in children (Wilson et al., 2010). Typically, CP is caused by abnormal development during the pre-natal period affecting movement, muscle tone, or posture (Sanger, 2003). MS is another neuromuscular disorder affecting more than 350,000 people in the United States where degradation of the myelin sheath causes difficulty coordinating muscle movement (Rosati, 2001). Currently, treatments are being developed to help prevent the progression of MS and to help coordinate muscle movements.

Recently, alternative approaches seek to maintain the enthusiasm of the patient during therapy while providing a multisensory experience to improve not only physical symptoms, but also aspects of self-control and self-confidence. Maintaining enthusiasm is especially important for children to obtain positive results (Casady et al., 2004; Shurtleff et al., 2009). One such technique, hippotherapy, utilizes the three dimensional movement of the horse to improve balance, strength, coordination, and postural symmetry in those with CP, MS, or related neuromuscular disorders. The forward, side-to-side, and rotational movement of the horse provides the rider with visual, vestibular, and somatosensory cues to help improve gait. While this therapy is a passive exercise for the patient, the individual must engage the core muscles to sit upright along with making small corrections due to the constant movement of the horse. Ultimately, by understanding how affected brain areas lead to symptoms in those with CP and MS, innovative therapies can be utilized such as hippotherapy to help improve balance, strength, coordination, and postural symmetry along with aspects of self-confidence.

I.i CEREBRAL PALSY

CP describes a set of non-progressive motor disorders as a result of injury to the brain during early development, including damage that occurs during preterm, neonatal, or postnatal periods. Spasticity and contractions as well as difficulty with feeding, drooling, communication, fractures, pain, and control of gastrointestinal function are some of the features associated with CP (Krigger,

2006). Damage to an upper motor neuron that often occurs in CP, affecting both sensory and motor components of cortical pathways, can lead to muscle contractures (Hoon et al., 2009; Smith et al., 2011). Contracture is defined as extreme muscle stiffness that leads to a limited range of motion and pain. Spasticity results from the net result of contractures and an absence of cross-bridge cycling, leading to a limited range of motion due to stiffness (Smith et al., 2011).

CP is oftentimes diagnosed through a myriad of features including the onset of symptoms (including neuromuscular problems such as spasticity, contractures, loss of motor control, a characteristic scissors gait with toe-walking, and muscle weakness), family history, complications with birth, hearing and vision impairment, sensitivity to pain, and other factors that might pre-dispose a child to having CP (Krigger, 2006; Ohata et al., 2007). Of the children affected by CP, in particular spastic diplegia or quadriplegia, 70 to 90% show structural brain differences. Magnetic resonance imaging can determine if there is damage to the white matter of the brain, which is associated with preterm birth (Hoon et al., 2009). By determining the level of damage, it is hopeful to improve the quality of life of those affected by CP. Much focus is emphasized on strength training procedures to improve force production, walking velocity, and gross motor function (Stackhouse et al., 2005; Arnould et al., 2007; Brandão et al., 2010; Dominao et al., 2010; Moreau et al., 2010).

I.ii MULTIPLE SCLEROSIS

MS is characterized by an inflammatory disorder of the central nervous system, specifically targeting the myelin sheath. Nerves communicate by conducting electrical signals known as action potentials down axons, which are insulated by oligodendrocytes that comprise the myelin sheath. When myelin is lost axons lose the ability to communicate effectively. Brain areas affected include ventricles of the cerebellum, brain stem, basal ganglia, and spinal cord; all key areas essential for communication between muscles and the brain in order to have coordinated and planned movements. While remyelination does occur, oligodendrocytes cannot completely reform the myelin sheath leading to a progressive manifestation of the disease (Fletcher et al., 2011; Gold et al., 2009; Kolls et al., 2004).

Symptoms of MS either occur in relapsing forms or in a progressive manner with permanent neurological defects. Neurological signs include changes in sensation (tingling, pricking, numbness), muscle weakness or spasms, difficulty with moving, coordination, gait, and balance, and/or problems with speech. It is also typical to have cognitive impairment with symptoms gradually getting worse over time (Gold et al., 2009). While it is unknown what specifically causes MS,

i.e., whether a genetic, environmental, or an infectious factor leads to pathogenesis, more is known about the mechanism of attack. It is thought that T cells, involved in the autoimmune pathology, respond against the myelin antigens leading to neurodegenerative events. T cells are a type of lymphocyte and help clear the body of infections. These cells become pathogenic once they have gained entry into the brain by disrupting the blood-brain barrier, which block or slow signal conduction via destruction of the myelin sheath (Burris et al., 2012; Fletcher et al., 2010). Without this important structure, axons are not able to send axon potentials to brain areas as efficiently. Since the brain regions targeted are involved in muscle movement and sensory integration, both motor and sensory components of the brain are impacted.

Treatment for MS often involves controlling for symptoms and preventing disability to improve daily living. Medications can be used to reduce severity but adverse side affects restricts their effectiveness. Physical, speech, and occupational therapy can be combined with medication to improve muscle tone and coordination but do not eliminate symptoms fully. Gait training can be valuable to those with MS to reduce fatigue during walking and improve activities of daily living (Sacco et al., 2011).

II. HIPPOTHERAPY VERSUS ADAPTIVE RIDING

Equine-assisted therapy began in Western Europe beginning in 1960s and moved to North America in the 1970s (Casady et al., 2004). In the United States alone, there are over 800 programs dedicated to using equine-assisted therapy for those with disabilities, giving evidence of the value and demand for this form of therapy. It is important to study the effectiveness of equine-assisted therapy because of the positive environment that the horse plays with the patient. Empirical research substantiates the effect of hippotherapy by measuring a functional outcome using tools such as the GMFM and PEDI to give evidence for the value of hippotherapy as a treatment option (Casady et al., 2004).

Two classes of equine-assisted therapy include adaptive riding and hippotherapy. Adaptive riding helps riders become as independent as possible while learning how to control and ride a horse. An appropriately sized horse is matched with the rider so that the horse's movements help with the rider's needs working towards a walk, trot, and canter. As patients often work in a group setting, communication and social skills can also be improved. Physical strength, muscle tone, balance, mobility, and hand-eye coordination are some of the visibly enhanced skills. The more subtle improvements are fortified self-esteem, self-control, and self-confidence. Hippotherapy is individualized to the rider in a one-on-one therapy session focusing on improving aspects of daily living rather than learning how to ride a horse. Speech, occupational, or physical therapists can

utilize the horse to help patients achieve goals. It is thought that the rhythmic pattern of the horse's gait mimics the movement of the pelvis during human gait. In addition to the rhythmic movements, the warmth and three-dimensional shape of the horse are believed to contribute to improvements in range of motion, tone, posture, balance, and coordination (Casady et al., 2004; McGibbon et al., 1998; Whalen et al., 2012).

Hippotherapy is a useful form of therapy because the child learns to anticipate movement as the horse walks in a repetitive, rhythmic pattern. The rider can produce compensatory mechanisms to counteract the movement of the horse such that his or her center of gravity will remain fairly neutral. Given an adequate period of time, the central nervous system can reorganize to affect sensory, muscular, vestibular, and visual systems and eventually lead to efficient and fluid movement patterns in daily activities (McGibbon et al., 1998; Casady et al., 2004).

III. THE ADVANCE OF HIPPOTHERAPY WITH CEREBRAL PALSY

It is important to understand the neurological adaptations that occur in those with CP to help understand the symptoms that result from the disorder. Prior studies reveal that damage incurred during the third trimester, when growth and differentiation of axons are occurring, impacts the periventricular white matter tracts (the white matter that is immediately to the side of the two lateral ventricles of the brain) that have function with motor movements (Counsell et al., 2003; Thomas et al., 2005; Hoon et al., 2009). Such neurological alterations can cause changes in the physiological function of muscles, resulting in weakened force production, lower walking velocity, and limited gross motor function in those with CP (Stackhouse et al., 2005; Arnould et al., 2007; Brandão et al., 2010; Dominao et al., 2010; Moreau et al., 2010). Other physiological factors related to CP hindering efficient walking include a velocity-dependent increased in resistance to muscle stretch, hypoextensibility, and impaired muscle recruitment and activation (McGibbon et al., 1998).

Those with CP typically lack control of trunk muscles; thus, it is essential for therapy programs to develop postural stability, both reactive and anticipatory (Casady et al., 2004). While hippotherapy is believed to improve autonomic compensatory mechanisms for postural stability, active postural adjustments can also be developed, which is important for CP. The therapist can have the patient reach for a toy so that the rider has to plan to adjust posture and maintain balance on the horse. Ultimately, the goal of hippotherapy is not to perform a movement better while on the horse but to move more efficiently and with ease when off the horse (Casady et al., 2004).

To determine if symptoms can be improved using hippotherapy in those

with CP, researchers have performed experiments measuring energy expenditure, gait, motor function, postural control, and trunk stability. Motor skills, such as stretching, mobilization of core muscle groups, orientation in space, and tactile reactions, can be learned while on the horse so that when off the horse, patients can activate muscles for enhancement of a functional task. An early study by McGibbon et al. (1998) evaluated if hippotherapy improved gait (stride length, velocity, and cadence), energy expenditure during walking, and motor function in those with CP. An 8-week, twice-weekly, hippotherapy session was completed for five subjects with a post test to measure functional improvement. Each session involved a) muscle relaxation/elongation and feeling the rhythm of the horse, b) postural alignment, and c) independent sitting with minimal assistance followed by active exercises using the trunk and extremities for muscle stretching, lengthening, and strengthening. There was a significant decrease in energy expenditure during walking (measured by examining heart rate) with improved scores related to walking, running, and jumping, as measured by GMFM (Gross Motor Function Measure) outcomes. Furthermore, there was a general trend towards increased stride length and decreased cadence.

McGibbon et al. (1998) suggest that hippotherapy is important for reducing energy expenditure by improving pelvic rotation, lateral displacement, and anterior tilt for correct center of mass positioning. Also, improving the stability of the hip and knee increases walking ability by controlling forward momentum. Importantly, decreased energy expenditure and more efficient walking may give a child greater self-confidence to walk longer and more often. Enhanced gait is supported as the horse provides continual postural challenges in the upright position so that the child has to constantly practice postural control and stabilization. Ultimately, McGibbon et al. (1998) demonstrate that hippotherapy can be useful for improvement of gait-related motor function in those with CP.

Sterba et al. (2002) provide further evidence for the effectiveness of hippotherapy in their 18-week session. Seventeen participants with CP were monitored using the GMFM every 6 weeks of therapy. After 18 weeks of therapy, the GMFM total score increased by 7.6% while aspects of walking, running, and jumping improved by 8.5%. Importantly, these results remained elevated at 1.8% six weeks after treatment. Sterba et al. (2002) hypothesized that the movement of the horse enhanced the movement of the rider's pelvis such that the rider exhibited a more functional gait. Furthermore, stimulation of the trunk muscles due to the forward and backward rocking motion caused an autonomic reaction in the rider to improve trunk stability and anterior/posterior tilt of the pelvis. However, in the non-ambulatory riders (5 of 17) there was no change in aspects of walking, running, and jumping or other GMFM outcomes. Due to the small subject pool, further studies should be completed to determine if

hippotherapy can benefit children with more severe disability (Sterba et al., 2002).

Given this previous research, Casady et al. (2004) examined if hippotherapy led to a general functional improvement in children with CP using the Pediatric Evaluation of Disability Inventory (PEDI) and GMFM as outcome measures. A 30-week study was performed with 10 children with CP (2.3 to 6.8 years of age). Subjects received hippotherapy treatment once a week for 10 weeks, riding 30 minutes on the horse, while continuing their conventional therapies at school or clinics. The GMFM was used to examine gross motor performance and to determine whether treatment was effective for children with CP, while the PEDI evaluated performance such as functional skills, mobility, and social function of children with CP. The horse's walking speed or movement pattern was adjusted accordingly while the subjects were encouraged to maintain postural alignment and to sit independently. Two post tests were conducted after the 10-week hippotherapy session (one week and 10 weeks after completion of the treatment).

Casady et al. (2004) determined a statistically significant effect after hippotherapy treatment but no significant change during non-treatment. PEDI social scores, PEDI total scores, GMFM crawling/kneeling scores, and GMFM total scores were all statistically significant. Three of the four ambulatory subjects had the largest change in GMFM score from the pre-test to the post-test while four of the six non-ambulatory subjects displayed the same result. Overall, there was between 1.0% and 10% change in the total GMFM scores during the 10 weeks of hippotherapy. In comparison, intensive physical therapy for eight months yielded a 4.2 to 6.2% change, Botox a 2.3% to 5.1% change after three months of injection, four months of treadmill training a 5.0 to 14% change, suggesting that hippotherapy may lead to nonspecific functional changes in a short period of time for those with CP similar to other treatment options (Casady et al., 2004).

Shurtleff et al. (2009) provided an important experiment to evaluate the effectiveness of hippotherapy by including a 12-week washout period after treatment. This washout period after treatment is valuable to determine if hippotherapy has lasting effects. In these studies, hippotherapy was used to assess whether head/trunk stability as well as upper extremity reaching ability in children with spastic diplegia CP could be improved. They included a 12-week intervention program as well as a 12-week washout period following treatment. Camera video motion detectors were utilized to observe movement patterns in 11 children (ages 5-13 years old). A mechanical barrel was utilized to challenge the trunk and head stability after treatment as well as a functional reach/target test. Shurtleff et al. (2009) observed significant changes with head/trunk stability as well as improved reaching efficiency after 12 weeks of treatment. Moreover, these changes were maintained following the washout period.

Based on the observations of Shurtleff et al. (2009), subjects receiving hippotherapy treatment had a reduction in translation movement of the upper trunk and head, important for visual and vestibular function and stability. Importantly, the rhythmic pattern of the horse allows children with CP to learn to control movement of the trunk and head. Control of the trunk and head most likely contributed to the improved gross motor movement of upper extremities observed in the 11 children. Future research can help identify the relationship between head and trunk stability with motor control of upper extremities. If such a relationship exists, vestibular and visual systems should also be improved with head and trunk stability (Shurtleff et al., 2009). Understanding the relationship between head/trunk stability with the sensory systems can allow therapists to develop treatments specifically geared to the needs of the patient. Critical to this study is the maintenance of results following treatment, indicating that improvement to trunk stability and upper extremities stretching is not limited to the treatment period (Schurtleff et al., 2009). After hippotherapy treatment, children can continue to develop skills with their new confidence and participate in daily activities more frequently. Table 1 summarizes the observations found from the mentioned studies above.

TABLE 1. Summary of Studies of Hippotherapy/Therapeutic Horseback Riding for Children with Cerebral Palsy

Study	Importance	Evidence	Participants	Treatment	Results	Conclusion
McGibbon et al., 1998	Effect of hippotherapy on gait (stride length, velocity, and cadence), energy expenditure during walking, and motor function in those with CP	Repeated measures within subject group, two baseline measurements taken 8 weeks apart followed by an intervention period, and a posttest	5 subjects with spastic diplegia and hemiplegia CP (age 9-11y, 3 boys, 2 girls)	Hippotherapy sessions for 8 weeks, 2x/week, 30 min session. Gait dimensions, energy walking expenditure (EEI based in on heart rate), and performance on GMFM E (walking, running, jumping)	No significant change in stride length (2 children showed significant increases in stride length at the post test ($p < 0.05$). Significant decrease in cadence at post test ($p < 0.05$), significance change in GMFM dimension E and EEI ($P < 0.05$)	Reduce energy expenditure by improving pelvic rotation, lateral displacement, and anterior tilt, correct center of mass-positioning, efficient walking, postural control and stabilization
Sterba et al., 2002	Effect of hippotherapy on gross motor function	Repeated measures within-subject, degree of disability for all riders was determined by the Gross Motor Function Classification System (GMFCS), baseline measurement taken 6 weeks before riding, followed by measurements at every 6 weeks during the riding period, and a posttest 6 weeks following the treatment	17 subjects with diplegia and quadriplegia CP subjects (ages 4+ y, 9 females, 8 males)	Hippotherapy sessions for 18-week session, 1x/week, 1 hour session, classified using the GMFM every 6 weeks of therapy; Children's Functional Independence Measure (WeeFIM) determined riders' level of independence in self-care, sphincter control, transfer ability, mobility, communication, and social interactions	No significant difference on WeeFIM, no significant different on GMFM after 6 weeks, significant increase in dimension E of GMFM after 12 weeks ($p < 0.02$), significant increase in total GMFM after 18 weeks ($p < 0.04$). GMFM dimension E also shows significant increase at 6 weeks post-test ($p < 0.03$). Children with severe symptoms had no changes in GMFM total score of dimension E	Stimulation of trunk muscles via forward/ backward motion of the horse cause autonomic reaction to improve trunk stability, and anterior/posterior tilt of pelvis. Non-ambulatory riders show no change after hippotherapy.
Casady et al., 2004	Effect of hippotherapy on general functional improvement in children with CP using the PEDI and GMFM as outcome measures	Repeated measures within-subject, two pretests and two posttests after the treatment (one week and 10 weeks after completion of the treatment)	10 subjects with spastic quadriplegia, hemiplegic, and athetoid CP (age 2.3-8.6y)	Hippotherapy with PT only for 10 weeks, 1x/week, 45 min session (20-30 on horse). Evaluated with PEDI and GMFM	Significant changes in all PEDI subscales ($p < 0.05$), significant change in GMFM dimensions except A. A statistically significant effect after hippotherapy treatment but no significant change during non-treatment. Overall, there was between a 1.0% and 10% change in the total GMFM scores during the 10 weeks of hippotherapy	Hippotherapy may lead to nonspecific functional changes in a short period of time for those with CP, 3 of 4 ambulatory subjects had the largest change in GMFM score from the pre-test to the post-test while 4 of 6 non-ambulatory subjects displayed the same result
Shurtleff et al., 2009	Effect of hippotherapy on head/trunk stability and reaching speed/efficiency	One group, pre-postoperative follow-up	11 subjects with spastic diplegia CP, (age 5–13y), 8 subjects without disabilities (age 5-13y)	Hippotherapy with OT/PT for 12 weeks, 1x/week, 45 min; motion detectors were utilized to observe movement patterns; A mechanical barrel was utilized to challenge the trunk and head stability after treatment as well as a functional reach/target test	Significant improvement in head and trunk stability and upper extremity functional reach test reduced translation of uppertrunk in response to a disturbance at the pelvis; changes maintained following the washout period	Improvement in trunk control and sitting balance following hippotherapy treatment, ability to adjust center of gravity after displacement

*GMFM consists of 88 items organized into five Dimensions: (A) Lying and Rolling; (B) Sitting; (C) Crawling and Kneeling; (D) Standing; and (E) Walking, Running, and Jumping.

In summary, the work of McGibbon et al. (1998), Sterba et al., (2002), Casady et al. (2004), and Shurtleff et al. (2009) demonstrate that hippotherapy once per week for at least 8-10 weeks can provide significant effects in motor movement for those with CP. Improvements in walking, running, and jumping as well as posture, head/trunk stability, and aspects of gait (stride length and cadence) are also demonstrated. Since it is unclear which disabilities exactly benefit from hippotherapy treatment, further research should be conducted with a larger subject group and control for degree of severity to establish if hippotherapy can be beneficial for a variety of disability levels (Whalen et al., 2012). For example, an individual with spastic diplegia might benefit more from hippotherapy than an individual with spastic quadriplegia. Additional longitudinal studies will also be beneficial to examine if the effects of hippotherapy after an 8-10 week session are maintained for a period of time after treatment. More research can provide therapists with a better idea of how long treatment should continue for those with CP and what population will benefit (Shurtleff et al., 2009).

IV. THE ADVANCE OF HIPPOTHERAPY WITH MULTIPLE SCLEROSIS

Like CP, those affected by MS exhibit dysfunctions of visual, somatosensory, and vestibular systems, and thus experience balance and postural instability. Patients with MS often report decreased range of motion, weakness of trunk and lower extremity, spasticity, and fatigue (Silkwood-Sherer et al., 2007). Poor postural control is often reported in people with MS where the primary mechanisms underlying changes include a slowed somatosenory conduction pathway and failure of central integration pathways (Cameron et al., 2010). Impairments can include an increased sway, delayed response to disturbances, and a reduced ability to deviate from their limits of stability. These impairments are likely reasons for increased falls and reduced gait speed in those with MS. Therefore, for functional improvement and to help with activities of daily living, it is essential to improve balance, gait, and falls in people with MS (Cameron et al., 2010).

Hippotherapy can aid in limiting the progression of MS and prevent impairments from worsening. Treatments have progressed to focus on a goal-oriented approach to help with balance problems and strengthen muscles in individuals with MS. This type of treatment is beneficial because impairments can be improved while allowing for functional recovery in every day life. Hippotherapy provides such a goal-oriented treatment for those with MS. Similar to treatment for CP, the movement of the horse allows for rotation in the pelvis and trunk for gait enhancement and postural stability (Heine et al., 1997;

Silkwood-Sherer et al., 2007). The three dimensional movement through space provides visual and vestibular cues to help patients develop balance and equilibrium reactions. The therapist can control the speed, direction, and abrupt halts/starts to aid in teaching the patients to stay upright on a surface that moves three dimensionally. Previous studies, the earliest by Mackay-Lyons et al. (1988), examined the effects of hippotherapy on postural sway, gait, and changes in the MS Minimal Record of Disability (MRD) and the Symptom Checklist-90-Revised (SCL-90-R). Their results showed no significant improvements in the MRD and postural sway assessments, although the subjects reported feeling more functional, whereas the SCL-90-R scale showed improvement during walking. The next researchers to examine the effect of hippotherapy on different physical functions (such as balance, spasticity, strength, coordination, and activities of daily living) demonstrated improvement in ten of the eleven subjects with MS (Hammer et al., 2005). While hippotherapy affected subjects differently, the most consistent improvement observed among all subjects was in balance (Hammer et al., 2005).

While there is potential for hippotherapy to be beneficial for those with MS, it is unclear how effective hippotherapy is for improving balance and postural stability (Silkwood-Sherer et al., 2007). Silkwood-Sherer et al. (2007) hypothesized that hippotherapy would allow MS subjects to improve balance while those not receiving treatment would display no change. Silkwood-Sherer et al. (2007) assessed improvement using the Berg Balance Scale (BBS) and the Tinetti Performance Oriented Mobility Assessment (POMA). To evaluate if subjects were able to integrate visual, vestibular, and somatosensory systems (a common difficulty for those with MS), the Clinical Test for Sensory Interaction on Balance (CTSIB) was utilized.

Hippotherapy treatment was completed for nine subjects with MS for a 14-week period. Assessment with the BBS and POMA was conducted at 0, 7, and 14 weeks. CTSIB information allowed the therapist to manipulate activities by taking away the sense on which the subject most relied. Silkwood-Sherer et al. (2007) observed statistically significant difference in scores for the BBS and POMA for the intervention group (and not the comparison group), with the biggest difference found between weeks 7 and 14. Furthermore, there was a statistically significant difference found in week 14 between the two subject groups for the BBS (and not for the POMA). Given these results, hippotherapy shows improvement of balance for those with MS.

Compared to conventional physical therapy treatments for MS, hippotherapy may be equivalent for improving postural stability in these individuals. Smedal et al. (2006) examined the effects following NDT training of 1 hour per day, 5 days a week in 2 patients for balance and gait effects. This study showed improvements in BBS scores; however, the gains in the

hippotherapy treatment were more pronounced. However, it should be noted that this finding might be due to the small subject pool. It will be important to compare techniques normally applied to treatment of MS with hippotherapy for improving postural stability (Silkwood-Sherer et al., 2007). Table 2 outlines the effects of hippotherapy as observed by the researchers above.

TABLE 2. Summary of Studies of Hippotherapy/Therapeutic Horseback Riding for Individuals with Multiple Sclerosis

Study	Importance	Evidence	Participants	Treatment	Results	Conclusions
Mackay-Lyons et al., 1988	Effect of hippotherapy on postural sway, gait, and changes in the MS Minimal Record of Disability (MRD) and the Symptom Checklist-90-Revised (SCL-90-R)	-	-	-	No significant improvements in the MRD and postural sway assessments, although the subjects reported feeling more functional. SCL-90-R scale showed improvement during walking	-
Hammer et al., 2005	Effect of hippotherapy on different physical functions (such as balance, spasticity, strength, pain, coordination, activities of daily living, and health-related quality of life)	Single-subject experimental design, type A-B-A	11 subjects with MS were studied (age 35-61y)	Hippotherapy sessions for 10 weeks, 30 min sessions, measured a maximum of 13 times using the BBS, walking a figure of eight, the timed up and go test, 10m walking, the modified Ashworth scale, the Index of Muscle Function, the Birgitta Lindmark motor assessment, part B, and individual measurements. Subjects also reported self rated measures	Improvement in 10 of the 11 subjects with MS in one or more of the variables. Most notably was improvement in balance as well as pain, muscle tension, and ADL	Hippotherapy shows potential for the treatment of balance disorders in those affected by MS
Silkwood-Sherer et al., 2007	Effect of hippotherapy on improving postural instability in individuals with MS	Nonequivalent pretest-posttest comparison group design	9 individuals (age 31-72y; 4 males, 5 females) received weekly hippotherapy intervention. 6 individuals (age 36-63y; 2 males, 4 females) served as a comparison group	Hippotherapy sessions for 14 weeks, 1x/week. Comparison group received no hippotherapy treatment. All participants were asses with the BBS and POMA at 0, 7, and 14 weeks	Significant improvement in group receiving hippotherapy from pretest to posttest on the BBS (mean increase of 9.15 points) and POMA (mean increase of 5.13) scores. No significant changes in BBS (mean increase of 0.73) or POMA (mean decrease of 0.13). Statistically significant difference between the two groups in final BBS scores	Hippotherapy shows potential for the treatment of balance disorders in those affected by MS

V. CONCLUSION

As provided by the current studies evaluating the effect of hippotherapy on CP and MS, this innovative treatment shows initial validity as a method for improving symptoms related to postural control, balance, and gross motor skills. The movement of the horse effectively mimics the gait of a human; thus, treatment can benefit those affected by postural instability and a dysfunctional gait (Heine, 1997). As the horse pushes off with the hind leg, the pelvis in concordance with the same side will drop leading to a lateral pelvic tilt in the rider. As the horse continues to step forward, it must laterally flex its spine while providing pelvic rotation for the rider. Upon striking the ground with the hind leg, the horse shifts its center of gravity. The riders must adjust their own center of gravity as they experience a lateral pelvic displacement. Changing the tempo or direction of the horse can enhance these properties and the degree of pelvic challenge. The rider must learn techniques to balance on the horse and hopefully these movement patterns translate to every day life (Heine, 1997).

To further verify hippotherapy as a treatment option, large randomized and controlled trials should be completed with specific protocols to target individualized aspects of the disorders (Shurtleff et al., 2009). For example, a study could evaluate how hippotherapy affects individuals with more severe forms of CP or MS, such as quadriplegic CP or those with severe MS. Other studies could also answer questions about how long treatment is needed to observe functional improvement. Most cases observe patients for 8-10 weeks; however, it would be useful to note changes if the experiment were conducted for a longer period of time. This information would clarify if the effects of hippotherapy reach a plateau after a certain time period or if motor function continually improves. Also important would be to assess if functional outcomes remain after completion of treatment and if longer treatment periods are more successful at maintaining motor skills and postural stability.

Importantly, hippotherapy addresses aspects of motor, visual, tactile, and vestibular systems. Cognitive, communication skills, peer interaction skills, and self-confidence can also improve with the aid of hippotherapy treatment (Casady et al., 2004; Heine, 1997; Shurtleff et al., 2009). Not all therapy techniques can combine all these aspects into one treatment while maintaining the interest of the patient. However, there are certain limitations to hippotherapy that might restrict who can benefit. The rider must be able to sit on the horse. An individual with excessive lower extremity spasticity might not have the ability to sit astride the horse (Heine, 1997). Thus, it is reasonable to combine different therapy techniques that would a) allow the patient for some functional improvements in areas of postural stability, reduced spasticity, and motor skills, and then b) use hippotherapy for further treatment to enhance functional improvement and

maintain the interest of the patient. Likewise, the tone of muscle in the trunk as well as head stability is important to assess before hippotherapy treatment. The benefits of hippotherapy to produce autonomic postural adjustments are lost when other people are supporting the rider astride the horse (Heine, 1997). Other factors that would limit a patient from riding the horse include a weight limit, fear of horses/heights, or allergy to the horse dandruff.

VI. RECOMMENDATIONS

Ultimately, hippotherapy is relevant for children with CP and for people diagnosed with MS who are experiencing balance and postural instability. Riders must learn to adapt to changes produced by the horse in a three-dimensional setting and reduce the sway created by such movements (Casady et al., 2004). This process helps develop postural stability, motor skills, pelvic rotations, and aspects of gait. Through repetition and time, postural adjustments will become efficient leading to improved functional outcomes as the central nervous systems learns to counteract perturbing forces. Importantly, the motivation of the rider will enhance the outcome of hippotherapy as riding a horse is generally thought to be fun and rewarding (Casady et al., 2004).

Therefore, due to the benefits of hippotherapy, future recommendations for research should focus on how the horse promotes postural control and balance (Casady et al., 2004). Also beneficial would be an examination of the relationship between changes in postural stability and functional outcomes due to hippotherapy treatment. Homogenous studies including age and severity of the disorder will help generate precise results. After performing studies evaluating the physical effects of hippotherapy, further research can inquire about the outcomes of occupational or speech therapy in conjunction with the horse (Casady et al., 2004). If symptoms of CP and MS are improved, then it will also be valuable to examine how hippotherapy affects other neuromuscular disorders such as stroke and traumatic brain injuries.

VII. PERSONAL STATEMENT

After observing the effects of therapeutic riding at various centers in Colorado and Washington for two years and participating in hippotherapy sessions in Washington for four months concurrent with writing this review article, I marvel at the benefits children receive from the horse. During each session, children remark, “I love coming here,” “this is my favorite part of the day,” or “is time already over.” It is apparent that riders enjoy the experience on

the horse and do not think of it as therapy but a chance to enjoy the company of the horse and the people involved.

Often times one or two side-walkers will accompany the therapist alongside the horse to help with goals of the rider. This role has been my position while observing hippotherapy sessions. Little Bit Therapeutic Riding Center based in Woodinville, Washington has provided me with a wealth of knowledge including tack preparation, horse placement with riders, lesson planning, and running a therapeutic riding center. After walking alongside the participants in hippotherapy sessions, the most noticeable differences that I observe in the riders are overall happiness and enjoyment, willingness to participate in exercises, self-confidence, and eagerness to do more. It is these aspects that allow for functional improvement. Riders are learning how to problem solve, think for themselves, notice the way the horse moves, and learn from the experience. Riders are asked to close their eyes while the therapist cues the horse to halt suddenly or speed up to challenge trunk and postural muscles. Riders have commented about the movement of the horse and how they enjoy the side-to-side rocking motion or the warmth of the horse on lower extremities. At the end of the day, nothing is more exciting than for the rider to give a carrot to their horse and a pat on the head as an act of appreciation.

Current research supports the need for more studies that look at specific factors such as postural control and stability in homogenous populations. Furthermore,what is known about the effects of hippotherapy on those with CP, MS, or other related neuromuscular disorders remains largely unknown, further research should be implemented because of the enjoyment that the patients experience from the horse.

VIII. Supplementary Information.

The following describes the lessons I observed for the time I was at Little Bit Therapeutic Riding center.

Journal Entries.

Week 1: 2/6/13

The horse was tacked with a small surcingle, blue vaulting pad, long lunge lines, and earplugs. This particular horse is useful for therapy sessions as he has a wider base and can be controlled from the behind with the long lunge lines. From what I can tell, the wider base is helpful for the rider to spread his legs open to help stretch leg muscles. The rider mounted the horse from the ramp and asked the horse to “walk on” after he was sitting safely on the horse. Before proceeding with the therapy session, the therapist asked the rider to verify that he was sitting

straight on the horse. First, the rider listed the four ways to check if he was sitting straight and then he performed the four items (visualize in his head if he is straight, check in a mirror, ask the horse leader if he is straight, and align his bellybutton with the horse's neck). Next, the rider was asked to stretch out his arms and then hold his arms out to the side to a 10 count. We went outside afterwards so the rider could concentrate without distractions. The rider then proceeding to perform a series of valuting poses as depicted by various pictures that the sidewalkers held up. He chose which poses he wanted to do. Various poses involve movements such as sitting cross legged while the horse is still moving, lying perpendicular to the horse on the belly and holding arms and legs up while the horse is moving forward, sitting backwards, kneeling on the horse, etc). The goal is to help strengthen core muscles while provided a forward motion. The rider arrived late so we had a shorter session. After the therapy session was over, the rider untacked and groomed the horse. He was so thrilled to groom the horse and seemed to enjoy the experience.

Week 2: 3/5/13
The horse was again tacked with a small surcingle, blue vaulting pad, long lunge lines, and earplugs. The rider mounted the horse from the ramp and asked the horse to "walk on" after he was sitting safely on the horse. Before proceeding with the therapy session, the therapist asked the rider to verify that he was sitting straight on the horse using the four ways mentioned previously. Again, we moved outside for ease of communication. After stretching arms and legs, the therapist handed a set of pictures to the rider with various cartoon people on the cards. The rider had to describe either the emotion of the cartoon person or to describe the scenario that would go along with the card. Afterward, the rider performed various vaulting poses to help with core strength. The sidewalkers helped the rider for stability and to make sure he would not fall off the horse. After the therapy session, the rider helped untack and groom the horse. This time we added on one more task of picking the front foot of the horse. The rider seems very excited to be there and enjoys the time he gets to spend on the horse.

Week 3: 3/12/13
The horse was tacked with a small surcingle, blue vaulting pad, long lunge lines, and earplugs. The rider mounted the horse from the ramp and asked the horse to "walk on" after he was sitting safely on the horse. After checking to see if the rider was sitting straight on the horse, we proceeded outside to the trail that loops around the barn facility. The focus of this week was to examine different methods to help calm the rider down when he becomes anxious/distracted/frustrated. The therapist began with showing the rider various pictures that displayed emotions of cartoon drawings. The rider had to say if the

picture was “calming” or “excitatory.” After going through the pictures, the therapist then asked the rider to reflect on was he could use to help him calm down. Two ways included pealing an orange or going for a car ride. We then proceeded to pay attention to the movements of the horse. The rider commented that he could really feel the sway of the horse on the trail. We went up a big hill and down the same hill so the rider could notice the different angles of the horse. We had the rider close his eyes to become more in-tune with the movements of the horse. After the lesson, the rider helped groom the horse. As the rider brushed the horse, he asked why horses shake when they are touched. Horses quiver when they receive a light touch because it is an adaptive reflex for shaking off flied or other bugs.

Week 4: 3/19/2013. Spring Break.

Week 5. 3/26/2013. Moving to a new facility. Most of the work done was transferring all equipment to the new facility. The new facility has a large, covered arena, tack barn, grooming stalls, and a welcome center. The welcome center has therapy rooms and a community lounge where parents and friends can watch the lessons. The new facility was designed to accommodate more lessons. Very neat!

Week 6. 4/2/2013. Still moving to a new facility. A reception was held welcoming family, volunteers, and staff to the new facility to become acquainted with the arena and surrounding area. The mayor of Woodinville attended the event. Little Bit appears to be highly respected in the hippotherapy/adaptive riding world.

Week 7. 4/9/2013. Classes resumed. The horse was tacked with a small surcingle, blue vaulting pad, long lunge lines, and earplugs. The rider mounted the horse from the ramp and asked the horse to “walk on” after he was sitting safely on the horse. After the warm-up, the therapist asked the rider to close his eyes and open then anytime the horse changed his pace. The horse handler controlled the pace of the horse (including slowing down, speeding up, or performing half-halts). The rider performed very well and was aware of the changed in horse movement for this exercise. Next, the rider practiced different vaulting poses again to help with core strength. One of the rider’s favorite was lying on his belly while extending his arms and legs out (so his body was perpendicular to the horses body). The therapist would make the exercise more challenging by asking the rider to hold either a leg or arm higher than the other. Another pose included having the rider lie on his side and extend his arm and leg up so he looked like a star. All these exercises were performed while the horse

was moving. Next, to work on balance we had the horse stop while the rider stood on the back of the horse. Again, after the therapy session the rider helped un-tack and groom the horse. The rider seems to really enjoy this time.

Week 8. 4/16/2013. The horse was tacked with a small surcingle, blue vaulting pad, long lunge lines, and earplugs. The rider mounted the horse from the ramp and asked the horse to "walk on" after he was sitting safely on the horse. Today's lesson focused on identifying different scenarios that can be frustrating for the rider. He was working on a group science project at school where students were asked to build a terrarium. The group memebers had a different opinion than the rider about what type of animal they wanted to keep in their terrarium. The rider commented that this was very frustrating and he did not want to compromise with his group. So, the therapist held out a sheet of paper with various "brain-eaters." Brain-eaters were defined as different items that can characterize a person such that they stray from normal routine or personality. The rider said his brain eaters were easily distractible, excitable, and stubborn. We then spent the remaining of the session brainstorming ways the rider could use to learn to better comprise, focus more effectively, and methods to help calm him down. We then performed one vaulting pose and finished by grooming the horse.

Week 9. 4/23/2013. The therapist called in sick so unfortunately not able to have any lessons this week.

Week 10. 4/30/2013. The horse was tacked with a small surcingle, blue vaulting pad, long lunge lines, and earplugs. The rider mounted the horse from the ramp and asked the horse to "walk on" after he was sitting safely on the horse. The patient was late so right after the rider verified he was sitting straight on the horse, he performed various vaulting poses. The rider chose his favorite five poses. I think that if the rider gets to choose what he does, the more enthused he is to perform them. All poses were first performed while the horse was standing still. Then after the rider was steady, the horse was cued forward while the therapist and myself helped stabilize the rider for one length of the arena. He was very proud of himself and asked if he could do more. My favorite quote from today was "I love being on Stetson I just want to stay forever." The therapist asked the rider what he noticed that had changed outside with the obvious response of no rain and no clouds! It was our first session with beautiful weather. Afterwards, we went outside for about 5 minutes to relax and enjoy the sun. The rider once again helped me untack the horse, helping with brushing. I have noticed that the rider likes to take his time with any activity. He won't finish brushing one section of the horse until he is sure it's clean and Stetson is happy. The therapist uses different techniques to encourage the rider to speed up the process.

Week 11. 5/07/2013. Today was the last lesson of the quarter. The horse was tacked with a small surcingle, blue vaulting pad, long lunge lines, and earplugs. The rider mounted the horse from the ramp and asked the horse to "walk on" after he was sitting safely on the horse. We began the lesson asking how everyone was doing. The rider seemed more quite today than normal. The rider seems to favor the vaulting poses, so for his last session we asked what five poses he would like to perform. Stetson seemed a little uneasy when the rider performed poses. It appears that Stetson will stop when the rider is unsteady on the horse. The rider commented, "It's like he is taking care of me!" Very cute. Before beginning those poses, the rider asked if he could create his own pose. He sat facing backwards with his legs up feet together and knees out. His hands were held up near his chest touching. The rider called this poses "Concentration" because he has to use a lot of concentration to stay upright. A lot of the poses the rider performed included poses that reminded me of Yoga. It must take an extreme amount of balance to stay on the horse and I am very impressed. After performing the next series of poses while the horse stood still, we went outside to enjoy the sunshine. The rider again helped with untacking and grooming. He did all the work for me! It was very inspiring to see the rider's progression and willingness to help. The rider seemed very appreciative of the horse, Stetson, so was willing to work and do what he was asked.

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